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The Use of Controlled Exposure Devices to Increase Braille Reading Rates[1]

by

Cleves J. Kederis, Carson Y. Nolan, and June E. Morris[2]

For a majority of the blind, braille reading is a slow means of obtaining information. Ethington (1956) found that the silent tactual reading rate for blind senior high school students was around 90 words per minute (wpm). According to Harris (1947, p. 449) the median silent visual reading rate for senior high school students was 251 wpm. Bixler, et al. (1961) found that listening comprehension of 6th - 8th grade blind pupils was nearly as good at 275 wpm as at the "...typical rate for a trained professional reader...." of 175 wpm. Comparatively, then, tactual reading is very slow--so slow, in fact, that the average blind reader must spend at least twice the time covering the same material as the sighted reader or the listener. Any development which would increase braille reading rates would have considerable educational value for the blind.

Numerous studies of print reading have reported the successful use of controlled exposure devices to improve "perceptual span" and/or reading rate (Vernon, 1931; McCullough, 1958). In the area of

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2 Cleves Kederis and June Morris are Research Associates and Carson Nolan is the Director of the Educational Research Department of the American Printing House for the Blind.

braille reading no specific studies of this nature have been made. However, Ashcroft (1959) conducted a study which was relevant to this problem. He evaluated the IBM Braille Reading Machine, a controlled exposure pacing device, for its potential as a means of reading braille. The subjects were nine adult braille readers. They read ordinary fictional material on the machine for 2-20 hours. One of the findings of the study was a median increase of 22% in the conventional braille reading rates of the subjects. This finding although not conclusively established as a result of machine reading, indicated that these devices might be useful for improving braille reading rates.

The present paper is a report of two studies which used controlled exposure techniques to increase braille reading rates. The hypothesis tested in both studies were the same:

1. Practicing braille reading under conditions of decreasing time of exposure will not significantly increase conventional reading rates.
2. Significant increases in conventional braille reading rates resulting from controlled exposure practice will not be maintained over an extended period of time following practice.
3. No differences in reading comprehension will occur as a result of controlled exposure practice.

Study I: The Effects of Reading Words, Phrases, and Sentences under Conditions of Successively Reduced Exposure Times.[1]

In this study the experimental subjects practiced reading braille words, phrases, and short sentences at decreasing exposure times. The purpose of this procedure was to exert constant pressure on the reader to move his hingers across the words more rapidly, thereby training him to recognize familiar words, phrases, and short sentences in increasingly shorter intervals. It was thought that the faster reading speeds attained under these conditions would transfer positively to the normal reading situation.

Method

Subjects.

The 30 subjects were selected from 62 braille readers in grades 6-12 at the Illinois Braille and Sight Saving School. The Gates Basic Reading Test, Type A, Form 1 was used to determine reading rates and comprehension scores. The readers were ranked by reading times and classified in three levels of fast, average, and slow. At each of the three reading rate levels five pairs of readers were matched on reading time, comprehension, and grade. Members of each pair were then randomly assigned to the experimental and control groups. Subject data are contained in Table 1. A more

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[1] Appreciation is expressed to the Superintendent and Staff of the Illinois Braille and Sight Saving School for their cooperation throughout the conduct of this study, and to Mr. Jack Curtis, formerly Psychologist at the Illinois School, for his help in supervising the practice sessions.

complete breakdown of reading times by level of reading rate is provided in Table 2. To obtain wpm reading rates on all forms of the Gates Test divide the reading times into 2100, the approximate number of words in each test.

Table 1

Descriptive Data of Experimental and Control Subjects

		Reading Time (min)	Comprehension Score	Grade	Sex M	Sex F
Experimental	Mean	32.45	23.00	8.80	5	10
	SD	12.93	.89	1.83		
Control	Mean	32.14	23.27	8.80	4	11
	SD	13.06	.93	2.01		

Apparatus.

The instrument used to train the experimental subjects was the tachistotactometer. This device can display braille material of lengths varying from one to thirty-six cells. The times of exposure are controlled and can be varied in steps of .01 second from .02 second to 10 minutes. The braille material, which is embossed on a special plasticized paper, is displayed to the reader by being pressed upwards through holes in a very thin brass screen. The spacing between dots and the height of the dots exposed in this manner approximate the standards used in publishing ordinary braille materials by the American Printing House for the Blind.

Materials.

The materials which were used for practice were patterned after the Dolch reading improvement materials. They consisted of words, phrases, and sentences of successively increasing length. There were 28 sheets of practice materials in all. Sheet number onecontained 36, two to four cell words, and sheet number 28 contained nine, 23-26 cell phrases and sentences. The length of words and phrases increased approximately one cell per page.

The criterion tests for determining the subjects' reading rates and comprehension before and after practice were the Gates Basic Reading Tests, Type A. All four forms were used.

Procedure.

The complete experiment required a total of 26 sessions. Four sessions, each approximately one hour long, were required to give the four equivalent forms of the Gates Basic Reading Tests. In the other 22 sessions the experimental subjects practiced on the reading materials. The practice sessions were one-half hour long and took place on consecutive school days.

The first reading test, Form one, was administered to the group of 62 braille readers approximately one month prior to the practice program. Form two of the Gates tests was administered to the group of 30 experimental and control subjects immediately following completion of the program. This test was given under motivated conditions, i.e., an award of five, three, and one dollar(s) was given to the three individuals making the greatest gains over their initial reading rates while maintaining their previous comprehension

level. Forms three and four of the reading tests were given under unmotivated conditions one and two months, respectively, subsequent to the practice program.

The practice sessions were held in the afternoon and evening of each day, so as not to interfere too much with the subjects' class schedules. Either three or four subjects at a time practiced reading during each of four daily sessions. The subjects' daily sessions were variable depending on class and school commitments. All of the sessions were conducted in one large room. The subjects were seated near each of the four corners of the room. During each session, there was one monitor for every two subjects, check identification of the materials, and regulate the timers. The monitors were senior college students majoring in psychology at McMurray College and Illinois College in Jacksonville, Illinois.

On the first day of reading practice the subjects were told the purpose of the study and were shown how to operate the tachistotactometer. To determine whether they understood and could do the task, the subjects practiced on the first sheet of the training materials. During this practice the initial exposure time was determined for each subject. This time was one which was long enough to touch all of the characters in the words but not necessarily identify the words. Further practice on the machines at these threshold exposure times was needed by the subjects and was given throughout the second session. After all the subjects had indicated they could do the task (which for most was by the end of the second session) the more formal practice was begun.

During the formal practice the subjects were required to read the practice words, phrases, and sentences at diminishing intervals of time. Reductions of .05 second were made in the exposure time whenever a complete and different line of the material on a sheet was accurately identified. To allow for the increase in number of characters on the successive sheets of materials the exposure time was increased .2 second between sheets. These procedures held throughout training unless the subject fell behind or could not identify any of the words. In such instances the exposure time was increased until some of the words were identified.

On each day of practice, the subjects were provided with a new set of reading materials. During the last four days of practice two sheets were used each day.

Results

In Table 2 are listed the mean reading times and comprehension scores for the fast, average, and slow readers in the experimental and control groups on the four forms of the Gates tests. Also included are the means and standard deviations of the reading times and comprehension scores for the total groups.

Thr reading times of test one and two were analysed by means of the comparison of changes technique described by McNemar (1955, p. 90). The results were non-significant, and indicated that the controlled exposure practice had very little effect on the normal reading rates of the experimental subjects. The practice may have had a differential effect on the readers within the different reading rate levels, but here too, the differences were not statistically

significant.

Table 2

Means and Standard Deviations

of Reading Times and Comprehension Scores

		Tests							
		1		2		3		4	
		R.T.	Comp.	R.T.	Comp.	R.T.	Comp.	R.T.	Comp.
Experimental Group	Fast	18.42	23.00	14.22	23.60	14.52	23.60	15.19	23.40
	Aver.	30.91	23.00	26.45	22.20	24.80	22.20	24.07	22.20
	Slow	48.02	23.00	35.37	22.80	34.54	23.20	33.96	23.00
	Group Mean	32.45	23.00	25.34	22.87	24.62	23.00	24.39	22.87
	SD	12.93	.89	9.31	1.31	9.12	1.46	8.80	1.09
Control Group	Fast	18.35	23.60	17.38	23.80	15.93	23.40	16.71	23.60
	Aver.	30.35	23.40	22.01	23.40	22.05	22.40	18.56	23.20
	Slow	47.73	22.80	32.23	21.20	31.84	20.80	28.31	20.40
	Group Mean	32.14	23.27	23.87	22.80	23.27	22.20	21.19	22.40
	SD	13.06	.93	7.84	1.72	8.77	1.47	6.54	2.12

Changes in Reading Rate. Both the experimental and control groups reduced their reading times on thest two from those on test one by approximately 24% which was significant beyond the .01 level of confidence. Over a period of the next two months, on tests three and four, this reduction increased to 29%. Within both groups, the slow readers made the largest reductions in reading times, the average readers intermediate, and the fast readers the least reduction. All of these changes in reading rate apparently resulted from the efforts of the readers to read faster.

Among the three reading rate levels some differences in reductions of reading rates following practice were found between the experimental and control groups, and although they were not statistically significant they were possibly educationally significant. The fast experimental readers reduced their reading times of test two by 25% compared with only a 5% reduction by their controls. Similar differences between the combined reading times of the average and slow readers in the experimental and control groups amounted to 8%, and that favoring the controls. Furthermore, these differences held up, for the most part, over the next two tests. Thus, the reading practice may have benefited the fast readers but not those in the slow and average reading rate groups.

Changes in comprehension. Both the experimental and control groups experienced a slight loss in comprehension on test two. The losses occurred among the average and slow readers in the experimental group and the slow readers in the control group. On subsequent tests the experimental subjects maintained their comprehension level while the average and slow readers in the control group continued to fall off slightly. Only the fast readers were able to maintain or, in the case of the experimental group, to improve their comprehension scores.

Study II: The Effects of Paced Reading Practice.[1]

In this study the subjects practiced reading contextual material presented at systematically increased word rates. The purpose was to force the subject to speed up their apprehension and integration of material presented in a continuous, meaningful context.

Method

Subjects.

Eight fast and eight slow readers in the experimental group were matched with an equal number of fast and slow readers in a control group. The subjects were chosen from 48 braille readers in grades 5-11 at the Kentucky School for the Blind. Two weeks prior to the beginning of the practice reading program Form one of the Gates Basic Reading Test, Type A, was administered to all the braille readers in these grades. Students receiving a comprehension score of 19 or above were ranked from fast to slow according to the times required to complete the listening test. From each group above and below the median reading time, eight pairs of readers were matched as closely as possible on reading time and grade level.

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1 Appreciation is expressed to the Superintendent and Staff of the Kentucky School for the Blind for their assistance in implementing this study and to Mrs. Lora Ennis, formerly at the American Printing House for the Blind, for her help in supervising the practice sessions.

One slow reader in the experimental group transferred to another school midway through the reading program. Consequently, his control was also dropped when the results were analyzed. Subject data can be found in Table 3. To obtain wpm reading rates divide the reading times into 2100, the approximate number of words in each test.

Table 3

Subject Data for Paced Reading Study

			Reading Time (min)	Comprehension Score	Grade	Sex M	Sex F
Experimental Group	Fast	Mean	22.72	22.88	8.12	4	4
		SD	2.95	.78	2.03		
	Slow	Mean	35.97	21.12	6.50	4	4
		SD	4.62	1.64	1.31		
Control Group	Fast	Mean	23.17	23.38	7.88	4	4
		SD	2.59	.99	1.69		
	Slow	Mean	35.02	22.62	6.88	5	3
		SD	3.85	1.06	1.13		

Apparatus.

The IBM Braille Reading Machine was used to control the presentation rate of the practice materials. This device displays braille composed of metal pegs projected through a continously moving plastic belt. The length of the display is approximately six inches. A punched paper tape controls the content of the braille display. The rate of movement of the belt is regulated by a variable speed motor, and, in terms of word rates, ranges from 50-250 wpm. This rate is

based on five braille characters a word.

Materials.

The materials used for the paced reading practice were two books: The Rainbow Book of Nature by Donald C. Peattie, a literary naturalistic work, and They Saw America First by Katherine Bakeless, a literary historical work. The vocabulary levels as listed in the American Printing House for the Blind catalog are 5th through 9th grades and 7th grade through adult, respectively.

The criterion tests used were the first three forms of the Gates Basic Reading Tests, Type A.

Procedure.

Completion of the study required approximately two and one-half months. Because only one machine was available and only one person at a time could use the machine, the study was carried out in two phases. The slow readers were trained during the first phase and the fast readers during the second. Both phases were exactly alike.

For each subject in each phase a total of 25 sessions was required. Three sessions, averaging approximately an hour each, were used to administer the first three forms of the Gates tests. The other 22 sessions, each one-half hour long, were used for the paced reading practice.

The three forms of the Gates tests were given in the same room and at the same time of day for all subjects. Form one, mentioned earlier, was given two weeks prior to the pacing practice. To establish a base for evaluating the effects of the reading practice,

Form two was given 12 days later under motivated conditions. The motivating factor was a monetary reward, the same as in the previous study. Form three was also given under motivated conditions on the day following completion of the pacing practice.

The paced practice sessions were held at the same time of day for each subject and in the same room on consecutive school days for all subjects. The first two sessions were used for adaptation to reading on the machine. Following explanations of the study and the operations of the machines in the first session, the subjects began reading at their motivated word rates. These word rates were obtained from the second reading test, Form two, the first motivated test. In a few cases an additional session was needed to adapt to this unique form of reading. In the third session, or after adaptation had occurred, pacing of the subject's reading began.

Pacing consisted of increasing the presentation rate of the material two and one half words per minute each day. The rate was increased without the subject's knowledge approximately five minutes after the start of each session. If a subject could not read at the increased rate he continued reading for the remainder of the session at his previous rate. Rate increases were attempted each day until the termination of the practice sessions. To check comprehension of the material, the subjects had to relate briefly what they had just read after each ten minutes of reading. This verbal report was evaluated for general significance, detail, and continuity of

the facts. A daily record was kept of each subject's progress.

Results

The subjects were enthusiastic throughout the pacing practice, and most all reported a seeming increase in their reading rates of regular braille material. On the last day of practice the daily records showed an average gain in machine reading rates for the slow readers of 21%. However, one subject from this group was unable to read on the machine at his motivated reading rate and finished pacing practice with a 44% loss. Excluding this subject the average gain for the slow readers was 44%. The average gain in machine reading rate for the fast readers was 30%. From the subjects' verbal reports it appeared that both groups achieved the gains in reading rate without too great a loss in comprehension. However, the slow readers seemed to lose more than the fast. The greatest decrement in comprehension for both groups was in the area of recalling specific facts or details in the content.

The data which were analyzed to determine the effects of paced reading practice were the reading times of the Gates Tests from both phases of the study. The comparison of changes techniques described by McNemar (1955, p. 90) was used for the analysis. Similar to the previous study, the results indicated that the pacing practice, while possibly benefiting the fast readers, had little overall effect on the reading behavior of the experimental subjects. See Table 4.

Table 4

Means and Standard Deviations of Reading Times and Comprehension Scores from Paced Reading Study

		Tests 1		Tests 2		Tests 3	
		RT	Comp	RT	Comp	RT	Comp
Experimental Subjects	Fast	22.72	22.88	18.22	22.12	16.36	22.62
	Slow	35.97	21.12	25.40 25.60*	19.62 19.43*	21.66*	17.28*
	Group Mean	28.34	22.00	21.81 21.66*	20.87 20.87*	18.83*	20.13*
	SD	7.84	1.55	7.44*	2.56*	7.99*	5.24*
Control Subjects	Fast	23.17	23.38	17.23	22.50	17.19	23.12
	Slow	35.02	22.62	28.06 28.14*	22.38 22.28*	23.41*	21.14*
	Group Mean	29.10	23.00	22.64 22.32*	22.44 22.40*	20.09*	22.20*
	SD	6.92	1.10	8.23*	2.20*	6.20*	2.54*

* Data computed without subject who did not complete pacing practice and his excluded control.

Changes in Reading Rate. As in the earlier study, aside from test adaptation, the subjects' efforts to read faster appeared to account for most of the differences in reading times among the three tests. The experimental and control groups combined reduced their reading times on tests two and three, 24% and 33%, respectively. Among the reading rate levels within the two groups, the

slow readers again made a greater overall reduction in their reading times than the fast readers, 37% and 27% respectively.

Between the experimental and control groups on test three there was only a non-significant 3% difference favoring the experimental group. However, separate comparisons of the two reading rate levels within the groups indicated a possible differential effect of the pacing practice. The slow experimental and control subjects reduced their reading times 15% and 17% respectively, while the fast experimental readers reduced their reading times 10% compared with no reduction by their controls. This latter difference was significant at the .02 level of confidence. Thus, the pacing practice may have benefited the fast readers but not the slow ones. On the other hand, a comparison of the overall changes in the fast experimental and control subjects' reading times from test one to test three showed only a 2% greater reduction by the experimental readers. This finding could be interpreted as resulting from some factor other than pacing practice, e.g. variability in the subjects' efforts to read faster.

Changes in Comprehension. In comprehension, the experimental subjects achieved lower scores on test one and lost more on test three than their controls. However, most of the loss occurred among the slow experimental readers. The fast experimental and control subjects had a similar overall loss from test one to test three of approximately 1%. For the slow experimental readers, the overall loss was 17%, while that for their controls was 6%.

Discussion

The results of both studies were quite similar. In each, no significant effects on test reading rates resulted from reading practice under the conditions of controlled exposure of the practice materials. However, among the reading rate levels there was a possible differential effect of reading practice favoring the fast readers. In both studies the fast experimental readers, subsequent to the reading practice, reduced their reading times more than their controls. This was not the case among the average and slow readers. These differences, except when tested separately in the second study, were not significant, but the fact they occurred in both studies gave substance to their being real effects.

Why did the reading practice not have a significant overall effect on the reading rates of the subjects, and why did the practice possibly effect the reading rates of the fast readers but not those of the slow and average readers? There appears to be a number of interrelated factors relevant to both of these questions. One is that the fast readers may have been more intelligent than the slow readers. Subsequent to the conclusion of these studies, Nolan and Kederis (1963) found that a randomly selected group of fast readers averaged 20 points higher on IQ than a randomly selected group of slow readers.[1] Hence, the fast readers would have been better equipped to gain something from the practice than the slow readers.

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[1] Since that time three other studies by the authors have confirmed that finding--author's note.

Another consideration is that the amount of practice was insufficient to both disrupt inefficient reading habits and reestablish better ones. From this standpoint (taking into account the possible higher intelligence of the fast readers), the practice may have been just long enough to improve the reading rates of the fast readers but not those of the slow readers. As a matter of fact, for the slow readers the practice may have been only long enough to disrupt their reading behavior. Some indication of this comes from the finding in both studies that the slow controls made greater gains in reading rate than the slow experimentals.

A third and perhaps the most important factor is that the perceptual unit of practice may not have been appropriate for all of the readers. In the study by Nolan and Kederis mentioned earlier, another finding was that the fast readers recognized the individual braille characters in half the time required by slow readers. On the basis of this and other evidence, the authors concluded that the perceptual unit in braille reading was the individual character and not the word. Thus, in the present study, while the fast readers may have profited some from the words and continuous prose, the more appropriate practice unit, especially for the slow readers, may have been the individual braille character.

The most important finding of the present studies was that stimulation of motivation to read faster resulted in remarkable reductions in reading times by all subjects. It was apparently responsible not only for average reductions in reading times of 24% in

both studies, but also for differential reductions among the reading rate levels--the slow readers proportionately reduced their reading times more than the fast readers. Furthermore, in the first study this factor may have been responsible for sustaining these reductions over a period of two months. These effects were highly significant both statistically and educationally. Not only do they emphasize the necessity for controlling motivation in studies such as these, but they also demonstrate possibilities for improving reading in the classroom through the manipulation of motivation.

Summary

In one study familiar words, phrases, and short sentences were read at diminishing time intervals on a rapid exposure device. In the other, literary material was read at increasing word rates on a pacing device. Both studies used an experimental and control group of 15 matched subjects divided into reading rate levels (fast-slow). The experimental groups practiced reading one-half hour daily for 20 consecutive school days. A monetary reward was used to control for motivation on the criterion tests. No significant effects of reading practice were found on pre and post reading tests. Motivational effects apparently accounted for 24% average reductions of reading times in both studies.

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